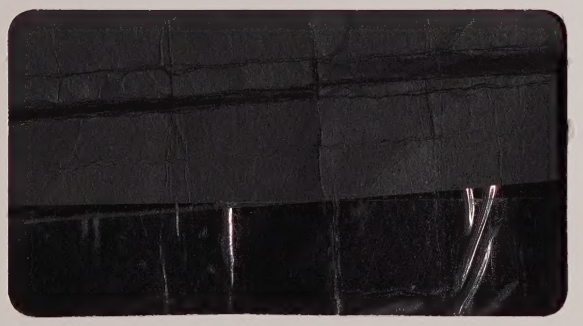

WAVETEK

WAVETEK SAN DIEGO, INC.

9045 Balboa Ave., San Diego, CA 92123

INSTRUCTION MANUAL

MODEL 621
PEAK/PHASE
DETECTOR

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Section	Title	Page
1	General Information	1-1
1.1	Introduction	1-1
1.2	Specifications	1-2
1.2.1	General	1-2
1.2.2	Phase Detector	1-2
1.2.3	Peak Detector	1-2
2	Installation	2-1
3	Operation	3-1
3.1	Manual Operation	3-1
3.1.1	Equipment Required	3-1
3.1.2	Phase Error Measurement	3-2
3.1.2.1	Scale Factor Determination	3-2
3.1.2.2	Phase Error Determination	3-4
3.1.3	Peak Detection	3-6
3.2	Automatic Operation	3-7
3.2.1	Equipment Required	3-7
3.2.2	Basic Language Programming Example	3-7
4	Theory of Operation	4-1
4.1	Operating Principles Overview	4-1
4.2	Detailed Circuit Description	4-1
4.2.1	Quadrature Phase Detector	4-1
4.2.2	Positive Peak Detector	4-2
4.2.3	Relay Control and Drivers	4-2
4.2.4	Power Supply	4-2
5	Parts and Schematics	5-1
5.1	Module Installation Drawing	5-2
5.2	Model 621 Assembly	5-3
5.3	Model 621 Module Schematic	5-4
Appendix A	Basic Language Programming Example Listing	A-1
A.1	Peak Detector Program	A-1
A.2	Quadrature Phase Error Program Listing	A-2

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Section 1 General Information

The Model 621 measures the output amplitude and quadrature phase accuracy of the Wavetek Model 650 Variable Phase Synthesizer.

Operation of the Model 621 is possible only when installed in a Wavetek Model 601/603 Signal Switching System. Instructions for operation of the Signal Switching System are contained in the Model 601/603 Signal Switching System Instruction Manual.

1.1 Introduction

The Model 621 (shown in figure 1-1) detects quadrature phase error between two quadrature (i.e., ±90° phase separation) sine waves of approximately equal amplitude and generates a dc voltage output which varies with the detected quadrature phase error (in degrees) by a scale factor.

The Model 621 has four input BNC connectors and one output BNC connector. The inputs are marked CH1, CH2, CH3 and CH4. The output is marked DCV OUT.

The Model 621 can measure the quadrature phase error between any single pair of channels 1 and 2, 1 and 3 or 1 and 4.

The Model 621 also detects sine wave positive peak voltage values on any selected input channel and generates a dc voltage output that equals the peak value of the input sine wave.

Phase error and peak voltage detection are mutually exclusive; only one feature can be used at a time.

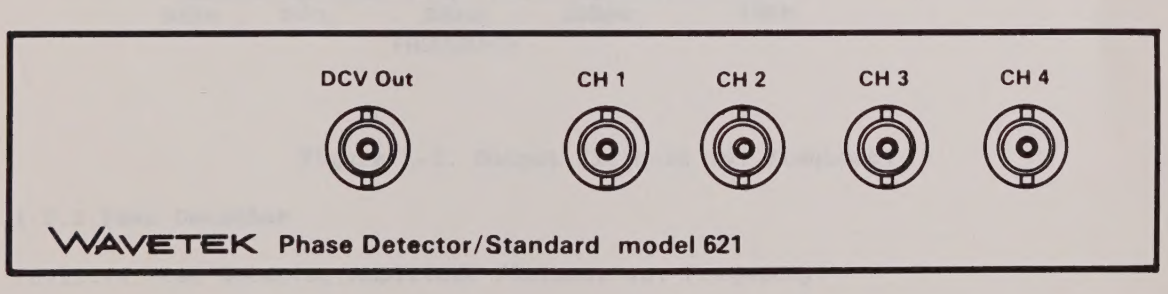

Figure 1-1 The Model 621 Peak/Phase Detector

1.2 Specifications

1.2.1 General

Number of input channels: 4.

Input Amplitude Range: 4 Vp-p ± 5%.
Input Voltage dc Offset: < 0.2 Vdc.
Input Voltage Matching: ± 0.5%.

Input Differential Phase: 90 ± 1°.

Number of output channels: 1.

Phase error output voltage calibration: 1.370 Vdc/deg. nominal.

Peak voltage output voltage calibration: 1.000 Vdc/V pk.

1.2.2 Phase Detector

Output Accuracy vs. Frequency

Phase:
± 3 millidegrees to 1 kHz.
± 20 millidegrees from 1 to 10 kHz.
± 100 millidegrees from 10 to 100 kHz.
± 300 millidegrees from 100kHz to 1 MHz.
± 500 millidegrees from 1 to 2 MHz.

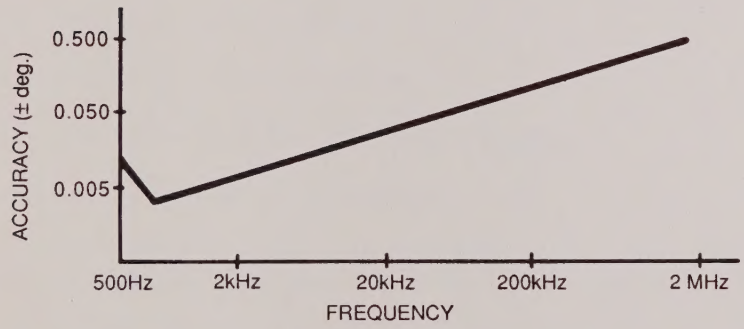

Figure 1-2. Output Flatness vs. Frequency

1.2.3 Peak Detector

Positive Peak Detector Amplitude Flatness vs. Frequency:

± 0.3% from 10 kHz to 100 kHz.
± 1.5% from 100 KHz to 1.0 MHz.
± 3.0% from 1.0 MHz to 2.0 MHz.

CAUTION

When installing the Model 621 module in the 601/603 Signal Switching System Chassis, insure that module alignment is correct and that the Model 601/603 electrical power is off.

Install the Model 621 Peak/Phase Detector in the Model 601/603 Signal Switching System as described in the Model 601/603 Signal Switching System Manual.

Section 3 Operation

The Model 621 can be operated in a Wavetek Model 601/603 Signal Switching System either manually or under program control of a Wavetek Model 6000 Instrumentation controller. Paragraph 3.1 details manual operation and paragraph 3.2 details automatic operation.

3.1 Manual Operation

Use the front panel controls on the Model 601/603 Signal Switching System to control the Model 621.

3.1.1 Equipment Required

Table 3-1 lists all of the equipment required to manually operate the Model 621.

Table 3-1 Equipment Required to Manually Operate the Model 621

Wavetek Model 600 Switching System
Wavetek Model 601 Master Chassis
Wavetek Model 603 Front Panel
Wavetek Model 618 Switch Module
Wavetek Model 615 Switch Module
Wavetek Model 621 Phase Detector
Wavetek Model 650 Variable Phase Synthesizer
Fluke Model 8520A DMM or equivalent
50 Ω terminations for each Wavetek Model 621 input. Each 50 Ω termination should be supplied with male and female BNC connector.
4 ea. 50 Ω coaxial cables, RG58/U or equivalent terminated with female BNC connectors, length less than 4 feet, length matched to 0.25 inches, Tektronix P/N 012-0482-00 or equivalent.

3.1.2 Phase Error Detection

The expression below gives the value for the Phase Error:

Phase Error = Scale Factor X Output Voltage

Data taken during the operating procedures that follow are substituted in expressions that yield:

- Scale Factor and
- Phase Error.

Tables 3-2 and 3-3 can be photocopied and used for logging the data called for in the operating procedure.

3.1.2.1 Scale Factor Determination

1) As shown in figure 3-1, connect the channel 1 FUNC OUT output of the Model 650 to channel 1 input of the Model 621 and connect the channel 2 FUNC OUT output of the Model 650 to the channel 2 input of the Model 621.

2) Connect the 'DCV' output of the Model 621 to the DMM.

3) On the Model 650, set the phase of channel 2 at - 91° relative to channel 1, set the amplitude of Channels 1 and 2 to 4.00 Vp-p and set the output frequency of Channels 1 and 2 to 1.0 MHz.

4) Use the Model 601/603 front panel controls to close the Model 621 relay K2 and to open relays K1, K6 and K5. Record the DMM reading in table 3-1.

5) Now close relay K6. Record the DMM reading in table 3-1.

6) Now change the phase of the 650 channel 2 output to +91° relative to channel 1 and then record the DMM reading in table 3-1.

7) Via the 601/603 front panel, open K6 and once again record the DMM reading in table 3-1.

8) To calculate the scale factor, use the expression below. Substitute the indicated step numbers with the DMM reading taken in the corresponding step of paragraph 3.1.2.1. For example: the number '4)' in the expression refers to the data recorded in step four in this procedure.

Calculate the Scale Factor according to the formula:

['4)' + '5)'] - ['6)' +'7)'] = Scale Factor

Table 3-2 Scale Factor Determination Readings

Step	Reading	Remarks
4	_____	
5	_____	
6	_____	
7	_____	['4)' + '5)'] - ['6)' +'7)'] = Scale Factor.
		Scale Factor = _____.

3.1.2.2 Phase Error Determination

1) As shown in figure 3-1, connect the channel 1 FUNC OUT output of the Model 650 to channel 1 input of the Model 621 and connect the channel 2 FUNC OUT output of the Model 650 to the channel 2 input of the Model 621.

2) Connect the 'DCV' output of the Model 621 to the DMM.

3) On the Model 650, set the phase of channel 2 at - 90° relative to channel 1, set the amplitude of Channels 1 and 2 to 4.00 Vp-p and set the output frequency of Channels 1 and 2 to 1.0 MHz.

4) Use the Model 601/603 front panel controls to close the Model 621 relay K2 and to open relays K1, K6 and K5. Record the DMM reading in table 3-2.

5) Now close relay K6. Record the DMM reading in table 3-2.

6) Now change the phase of the 650 channel 2 output to +90° relative to channel 1 and then record the DMM reading in table 3-2.

7) Via the 601/603 front panel, open K6 and once again record the DMM reading in table 3-2.

8) To calculate the phase error, use the expression below. Substitute the indicated step numbers with the DMM reading taken in the corresponding step of paragraph 3.1.2.2. For example: the number '4)' in the expression refers to the data recorded in step four in this procedure.

Calculate the Phase Error according to the formula:

Scale Factor X ['4)' + '5)'] - ['6)' +'7)'] = Phase Error

Be sure to include in the expression the value calculated for the Phase Error in paragraph 3.1.2.1

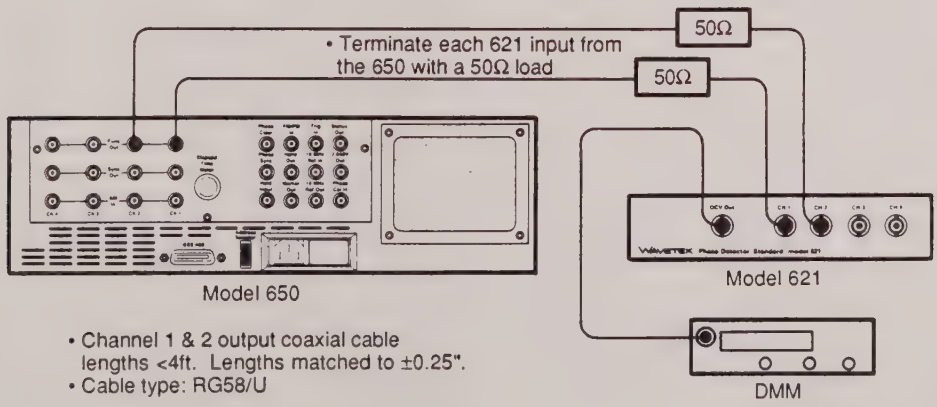
50Ω
• Terminate each 621 input from the 650 with a 50Ω load
50Ω
Model 650
Model 621
DMM
• Channel 1 & 2 output coaxial cable lengths <4ft. Lengths matched to ±0.25".
• Cable type: RG58/U

Figure 3-1. Model 621 Connections for Manual Operation

Table 3-3 Phase Error Determination Readings

Step	Reading	Remarks
4	_____	
5	_____	
6	_____	
7	_____	Scale Factor X ['4)' + '5)'] - ['6)' +'7)'] = Phase Error
		Phase Error = _____

3.1.3 Peak Detection

Follow the procedure in this section to measure the positive peak value of the sine wave appearing at any of the FUNC OUT outputs of the Wavetek Model 650 Variable Phase Synthesizer.

1) Figure 3-1 shows how the 621 is connected in a test system. Connect as shown.

2) Use the front panel controls on the Model 601/603 Signal Switching System to close relays Kn (where n is the number of the Model 621 input channel selected for measurement) and K5 of the Model 621.

3) Use the front panel controls on the Model 650 to set the desired FUNC OUT output amplitude to 4.00 Vp-p.

4) The DMM connected to the Model 621 DCV OUT output should read the absolute value of the positive peak of the signal appearing at the selected input; in this case the value is 2.000V. Consult the specifications in Section 1.2 of this manual to find the variance of this feature's accuracy vs. frequency.

3.2 Automatic Operation

Program the Model 6000 Instrumentation Controller to automatically control the entire test procedure.

3.2.1 Equipment Required

Table 3-4 Equipment Required For Automatic Operation

Wavetek Model 6000 Instrumentation Controller with Option 006 GPIB Interface Card
Dot Matrix Printer (Wavetek Model 6010 or equivalent)
Wavetek Model 600 Switching System
Wavetek Model 601 Master Chassis
Wavetek Model 603 Front Panel
Wavetek Model 618 Switch Module
Wavetek Model 615 Switch Module
Wavetek Model 621 Phase Detector
Wavetek Model 650 Variable Phase Synthesizer
Fluke Model 8520A DMM or equivalent
50 Ohm Terminations for each input from the Wavetek Model 650 to the Wavetek Model 621.

3.2.2 Basic Language Programming Example

Appendix A of this manual lists a Basic program that, when entered and executed on a Model 6000, automatically controls the Model 650 outputs, the DMM display, measures and calculates the Model 650 quadrature phase error and voltage peak values and generates a printout on the Model 6010 printer of the measurement results. Before running the program, connect the equipment called for in table 3-4 as shown in figure 3-2.

Complete information on how to program the Model 6000 to control the Model 601/603 Signal Switching System can be found in the associated instruction manuals.

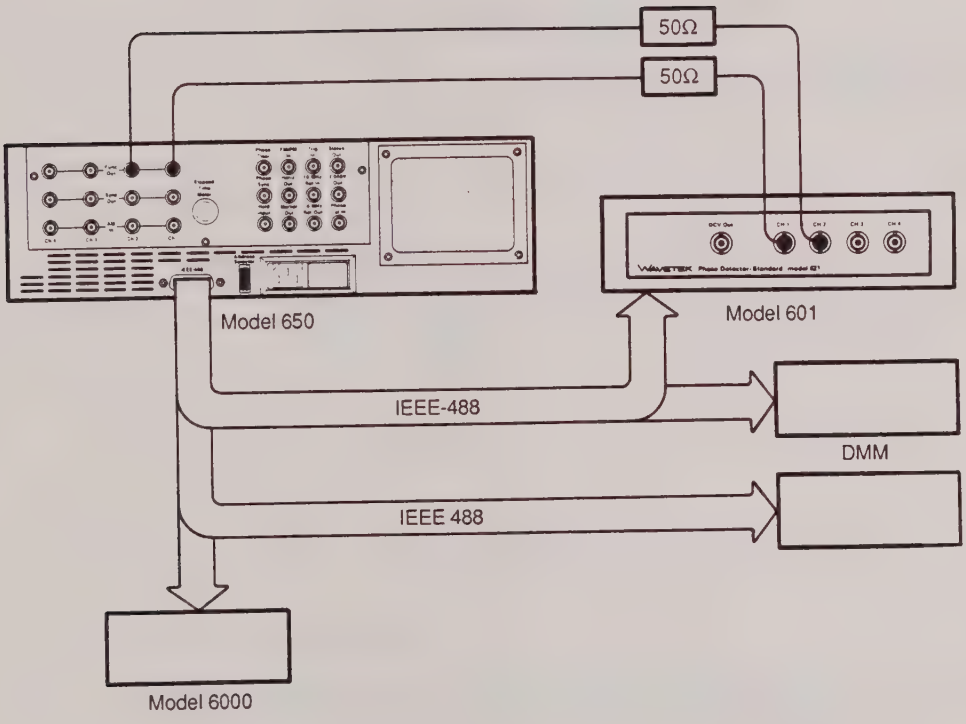

Figure 3-2. Model 621 Connections for Remote Operations

Section 4 Theory of Operation

4.1 Operating Principles Overview

Figure 4-1 shows a block diagram of the Model 621 circuit implementation.

The functional blocks are the:

- Quadrature Phase Detector
- Peak Detector
- Relay Control and Drivers
- Module Identifier
- Power Supply

The Quadrature Phase Detector Circuit generates a dc volatage proportional to the quadrature phase error between the two sine waves present at its inputs.

The Peak Detector circuit generates a dc voltage that exactly equals the positive peak voltage of the signal present at its input.

The Relay Control and Driver circuit receives relay control commands from the Model 601/603 Signal Switcher and accordingly energizes the correct relay.

The Module Identifier communicates module location information to the Model 601/603 Signal Switcher.

The Power Supply Circuit generates from the external + 12 volt supply a closely regulated + and - 5 volt supply for the Peak Detector circuit and converts the external + 12 volt supply to - 12 volts for the remaining circuits. The external + 12 volt supply is used as a positive supply for those circuits requiring it.

Figure 4-1 also identifies the function of each relay K1 through K5.

4.2 Detailed Circuit Description

Refer to the Phase Detector/Standard Module Schematic (No. 0103-00-2397) while reading this section.

4.2.1 The Quadrature Phase Detector

The Quadrature Phase Detector uses a summing/difference technique to obtain a dc error voltage that is directly proportional to the quadrature phase error at its inputs.

U5 sums, scales and half wave rectifies the signals from the common contact pair of relay K6. The scaled net sum of these signals, when greater than zero, appears at the cathode of CR4; the scaled net sum of these signals, when less than zero, appears at the anode of CR6.

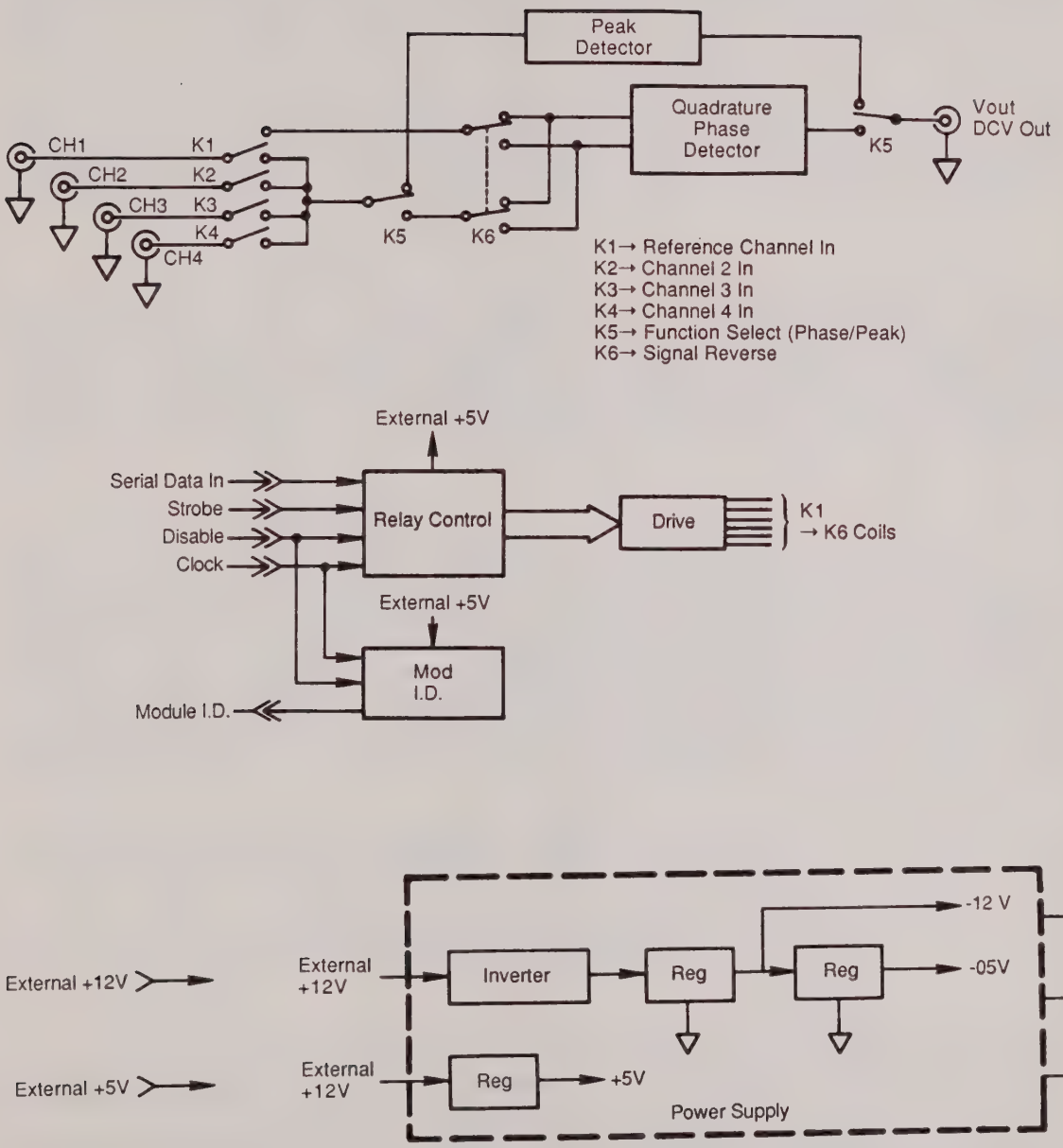

Figure 4-1 Model 621 Block Diagram

U7 multiplies by -3/2 one of the signals of the common contact pair of relay K6; the output appears at U7 Pin 10.

U6 scales, sums and half wave rectifies the signal from U7 Pin 10 and the signal appearing at one of the common contacts of relay K6. The scaled net sum of these signals, when greater than zero, appears at the cathode of CR5; the scaled net sum of these signals, when less than zero, appears at the anode of CR7.

U9 subtracts the net sum of the signals appearing at the cathode of of CR4 and the anode of CR7 from the signals appearing at the cathode of of CR5 and the anode of CR6. The output of U9 (pin 6) is an error voltage that is directly proportional to the quadrature phase error between the two signals appearing at the common contact pair of relay K6.

4.2.2 Positive Peak Detector

The integrated peak detector U8, drives the differential transistor pair Q3 and Q4 to charge C28 to match exactly the input voltage appearing at the K6 side of R36. Once C28 becomes charged, it stays charged until a voltage higher than the last appears at the peak detector input. CR9 prevents the discharge of C28 when the input voltage at R36 becomes less than the voltage stored on C28.

4.2.3 Relay Control and Drivers

The Relay Control and Driver function is controlled by U3 and U4. U3 is a shift register whose outputs control the relay driver integrated circuit U4. Relay control data is shifted into U3 by signals received form the 601/603 control logic. The logic level at the Data In input (Pin 2) of U3 is serially shifted into the shift register (whose stages are outputs Q1 through Q6) on the positive transition of the Clock Input at Pin3. The strobe input inhibits operation of the device whenever its logic level is low. The Q1 through Q6 outputs are placed in a high impedance state whenever the output enable is at a logic low.

Each of the outputs Q1 through Q6 of U3 connects directly to an input of U4, a seven channel darlington transistor array.

A logic high on any input of U4 turns on an open collector darlington transistor and hence its associated relay coil.

4.2.4 Power Supply

U10 regulates the external +12V to +5V. The +12V input appears on Pin 1; the regulated +5V output appears on Pin 3. C31 is a filter capacitor.

T1, Q1, Q2, CR2, CR3 and their associated components constitute a + to - voltage converter; positive feedback to the bases of Q1 and Q2 from T1 primary cause oscillation. The reflected oscillations in T1 secondary are full-wave rectified by CR1 and CR2 and are filtered by C15. VR1 is biased through R35 and R27 to generate a regulated -12V; the -12V is further regulated to a - 5V by VR2 whose output is filtered by C32.

Section 5 Parts and Schematics

This section contains the drawings listed below:

Title	Drawing Number
Module Installation	0002-00-0213
Model 621 Module Assembly	1100-00-2397
Model 621 Module Schematic	0103-00-2397

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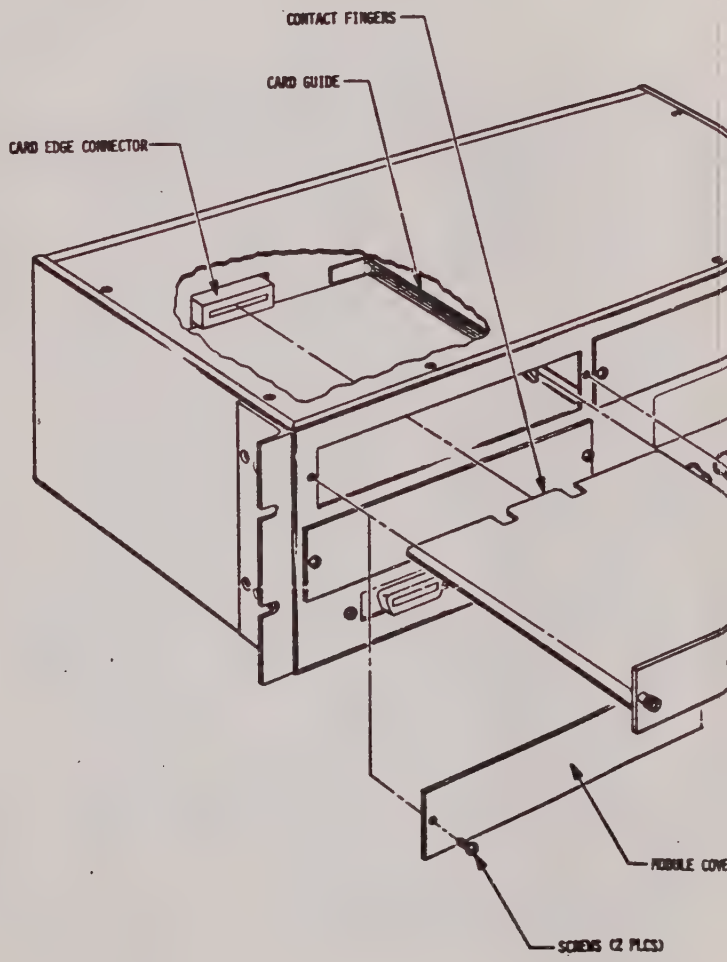
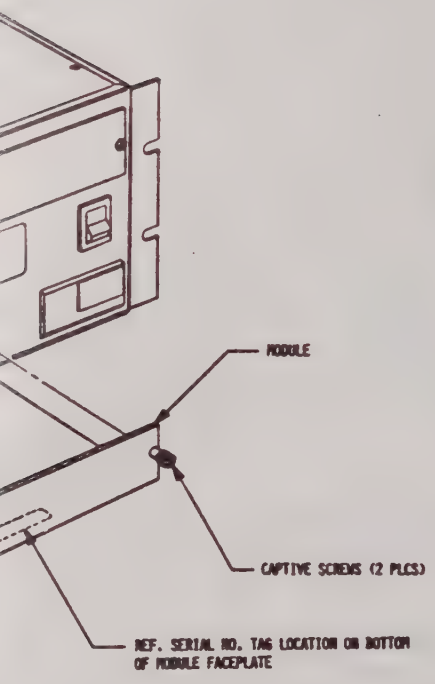


MODULE INSTALLATION INSTRUCTIONS

STEP 1. REMOVE SCREWS (2 PLCS) AND MODULE COVER PLATE.
STEP 2. INSERT MODULE P.C. BOARD INTO CARD GUIDES (BOTH SIDES), AND PUSH MODULE INTO CHASSIS. (NOTE: CONTACT FINGERS OF P.C. BOARD MUST MATE WITH CARD EDGE CONNECTOR IN CHASSIS).
STEP 3. FASTEN CAPTIVE SCREWS (2 PLCS).

NOTE: UNLESS OTHERWISE SPECIFIED



REV	ECN	BY	DATE	APP

REMOVE ALL BURRS AND BREAK SHARP EDGES

MATERIAL

FINISH
WAVETEK PROCESS

DRAWN CHERMACK DATE 10/7/88

TOLERANCE UNLESS OTHERWISE SPECIFIED
.XXX ± .010 ANGLES ± 1°
.X ± .03

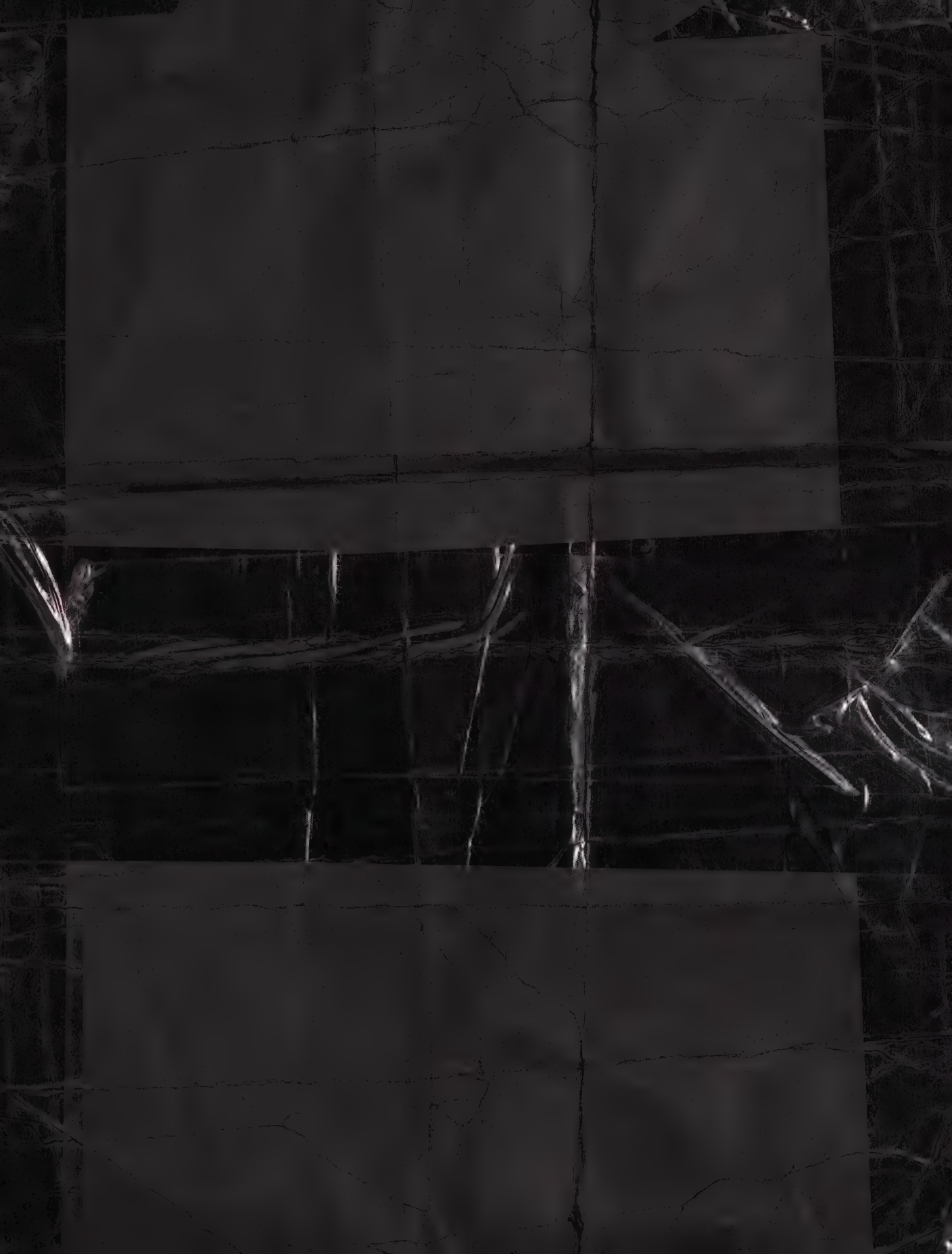
DO NOT SCALE DWG

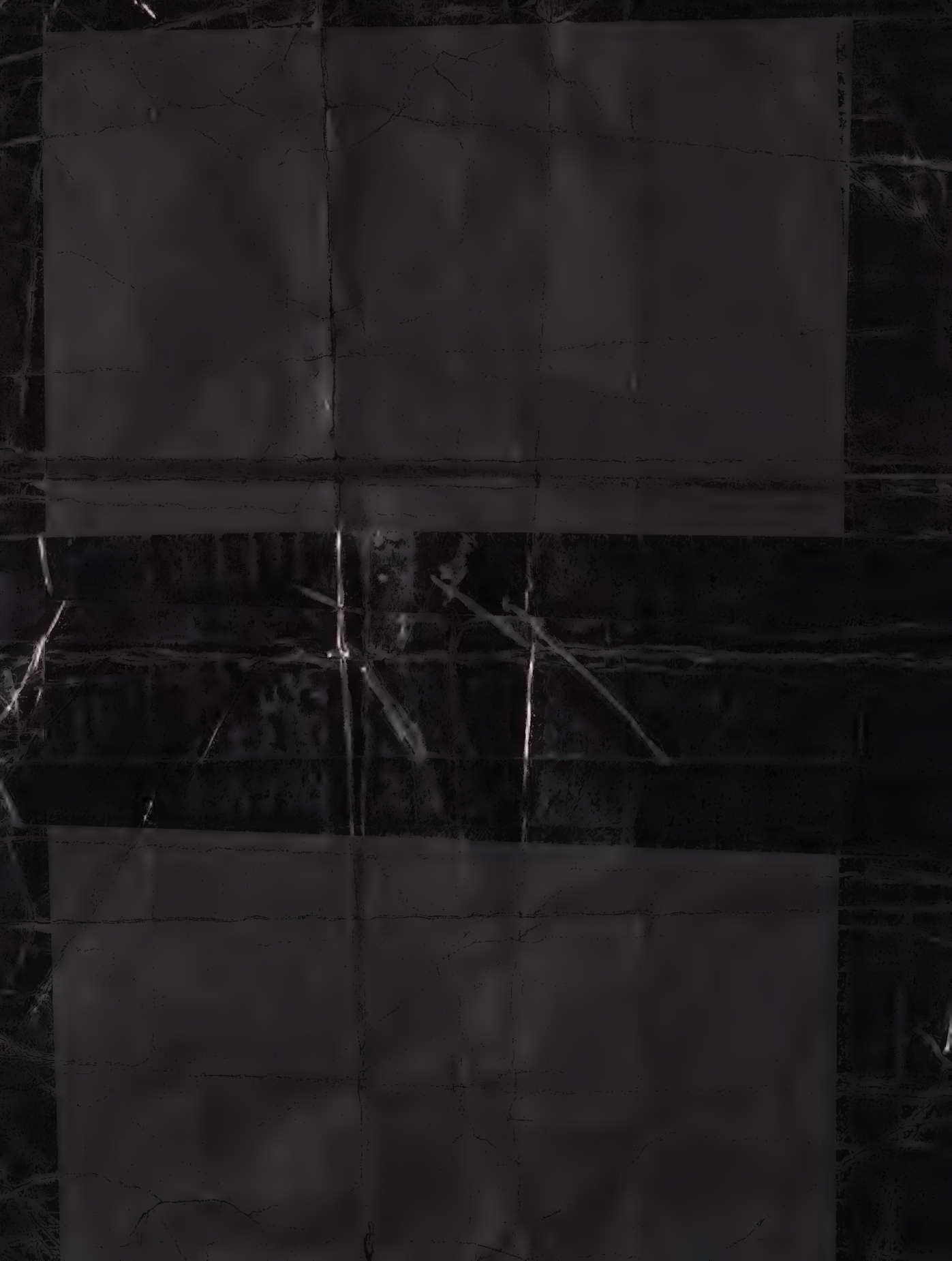
SCALE NONE

WAVETEK

TITLE
INSTALLATION DWG, SWITCH MODULE

600 SERIES	0002-00-0215	A
23338	SHEET 1	OF 1





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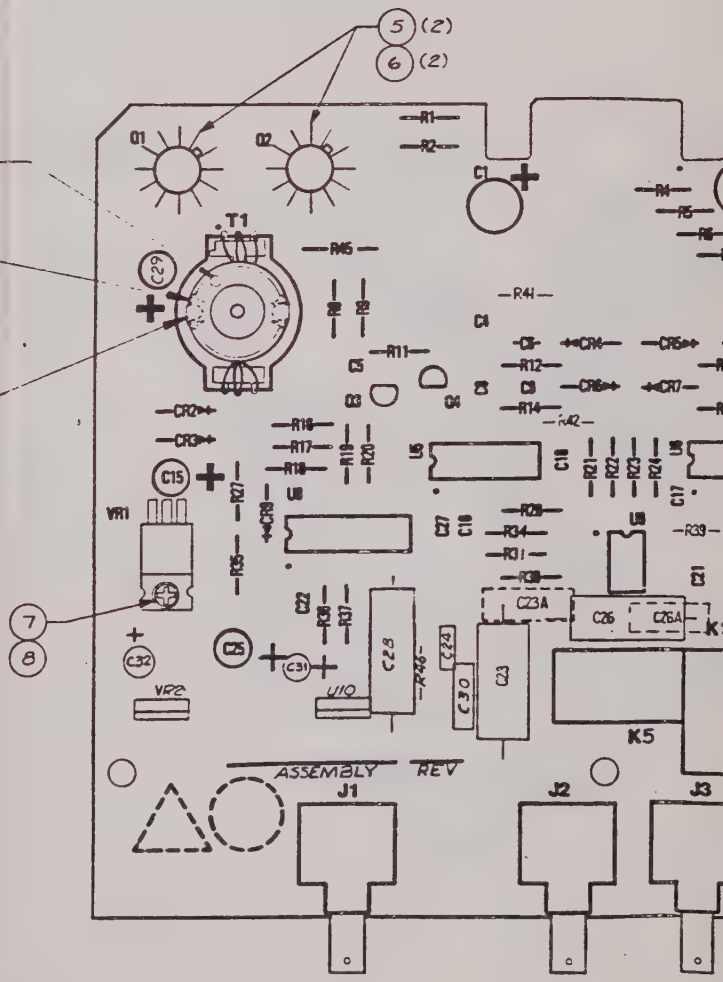
NOTE: RED DOT INDICATES P.N. NO. 1

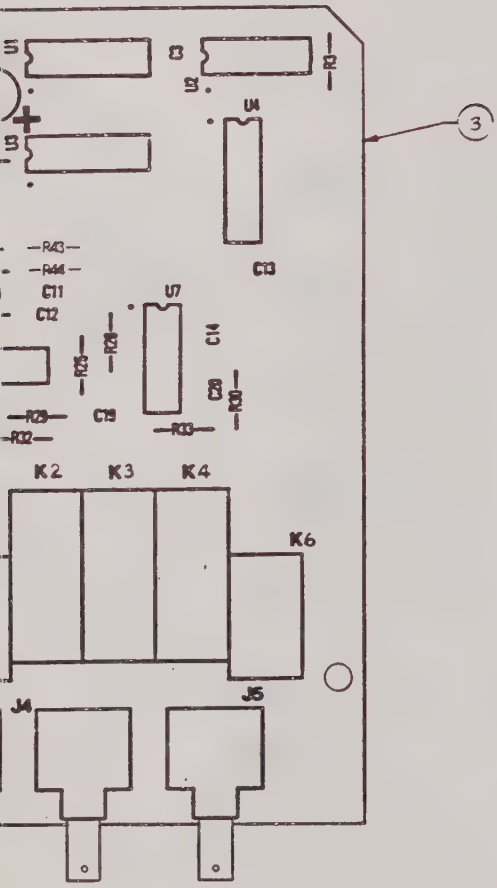
NOTE: FOLD SHARP TABS UNDER XFRMR. BEFORE INSTALLING IN P.C. BD. (4 PLS)

NOTE: INSERT ROUNDED TABS THRU HOLES IN P.C. BD. AFFIX T1 TO PC. BD. BY BENDING TABS UNDER PC. BD. AS SHOWN. (2 PLS)

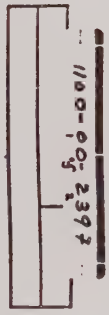


NOTE UNLESS OTHERWISE SPECIFIED

REV	ECN	BY	DATE	APP
B	RELEASE	SC	12/15/85	
C	7740	BR	9/6/86	
D	ECO # 7920	ML	9/5/87	



3



REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN CHEK MACK	DATE 10-1-85	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ ENGR 9/86		TITLE ASSEMBLY PHASE DETECTOR/ STANDARD MODULE
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1 XX ± .030		
	DO NOT SCALE DWG	MODEL NO 621	DWG NO 1100-00-2397 REV D
	SCALE 2/1	CAGE NO 23338	SHEET 1 OF 2

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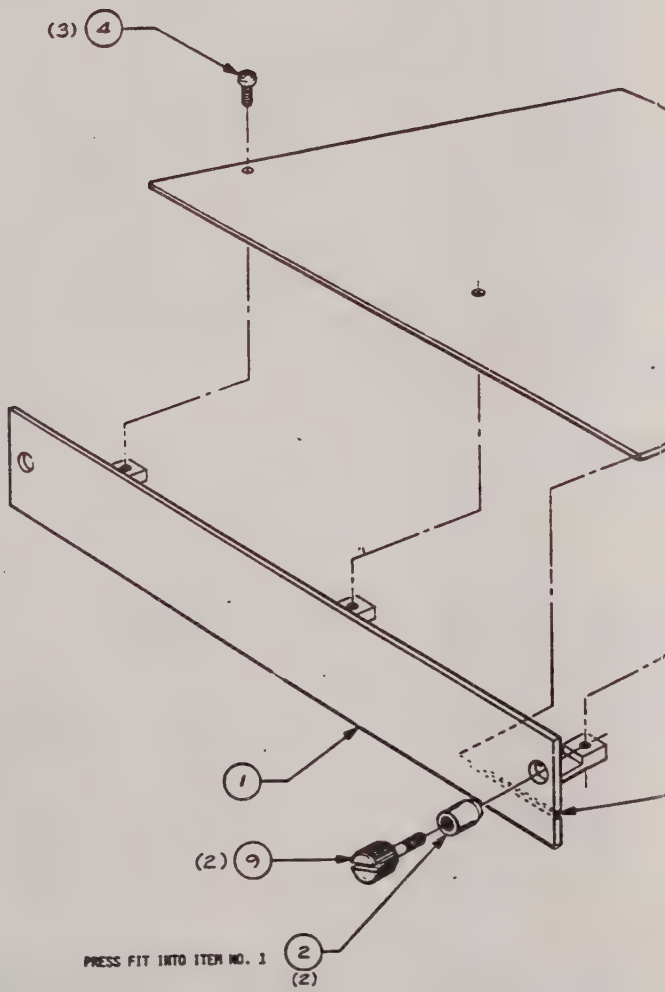
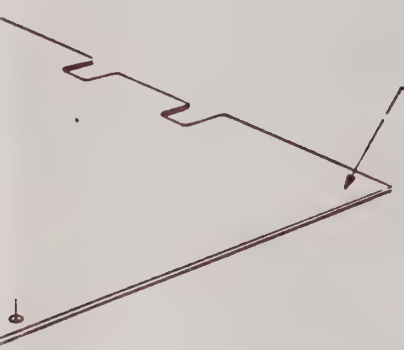
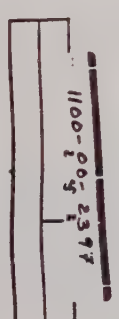


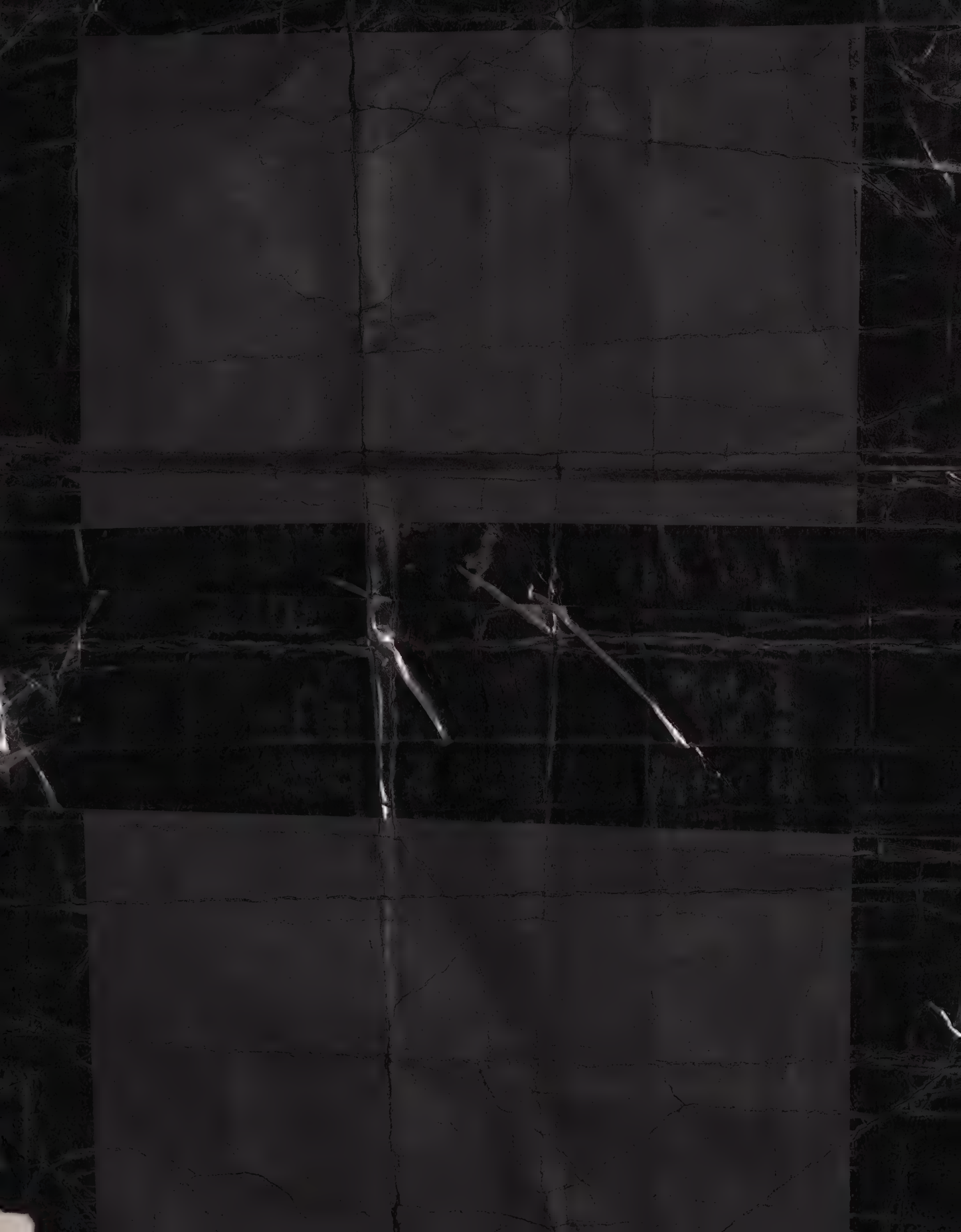
NOTE: UNLESS OTHERWISE SPECIFIED

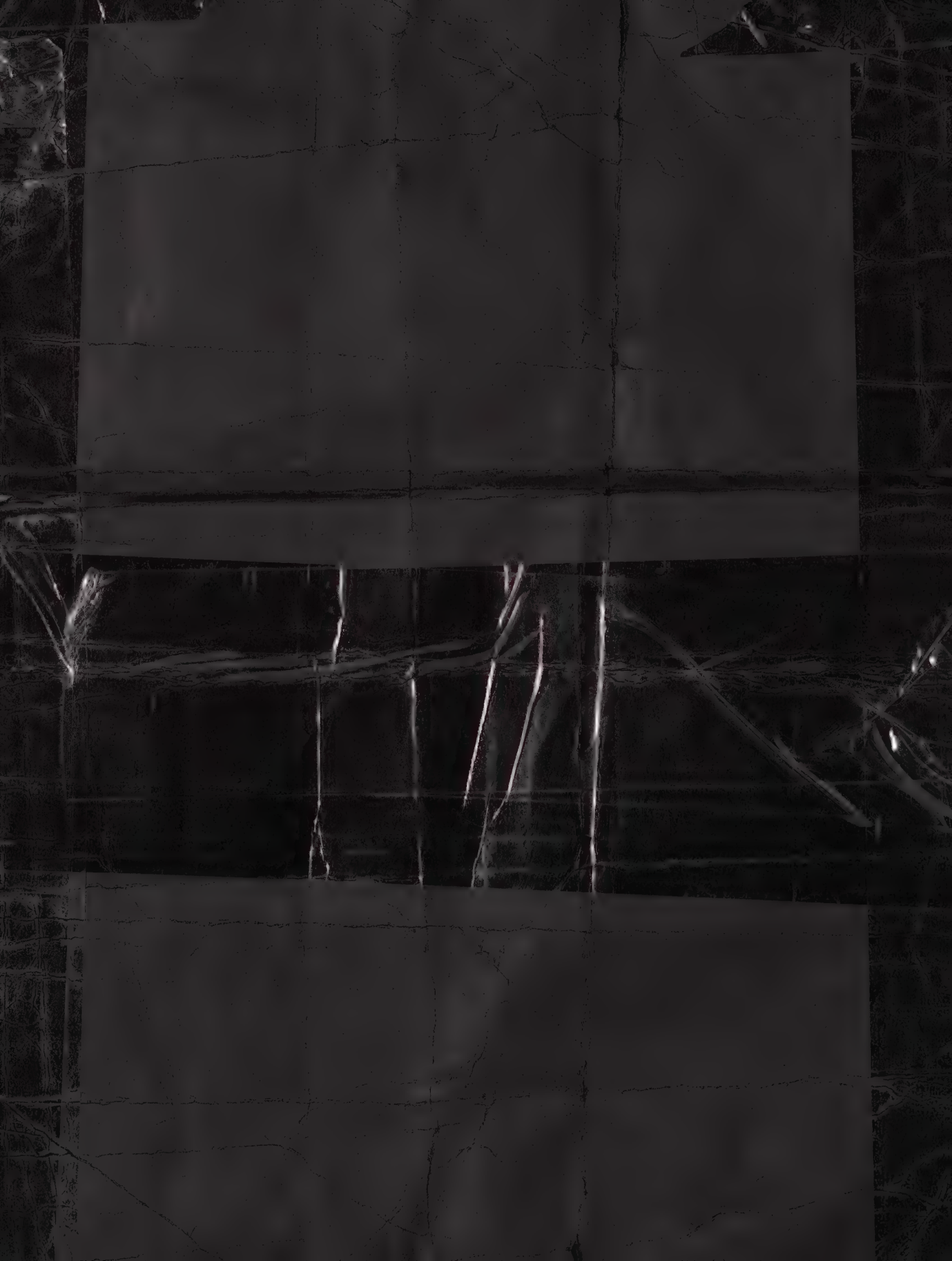




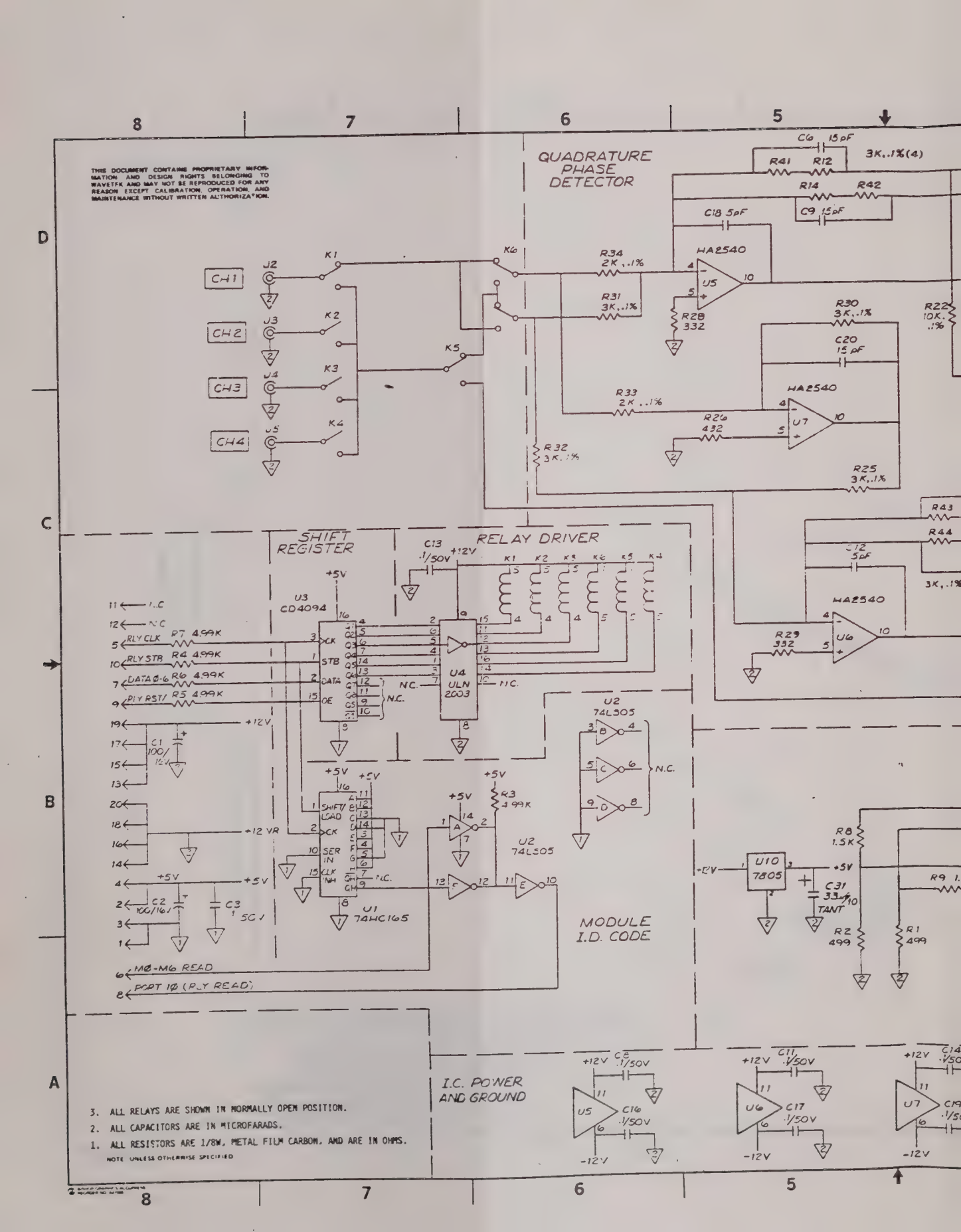
NOTE: LEADING EDGE OF PC BOARD FITS INTO SLOT OF ITEM NO. 1

REMOVE ALL BURRS AND BREAK SHARP EDGES	CHERMACK	12-14-65	WAVETEK
MATERIAL		12-15	TITLE: ASSEMBLY, PHASE DETECTOR/ STANDARD MODULE
FINISH: WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ± .010 ANGLES ± 1° .XX ± .030		
	DO NOT SCALE DWG		MODEL NO. 621
	SCALE: NONE		DWG. NO. 1100-00-2397 REV. D
			CODE IDENT NO. 23338 SHEET 2 OF 2



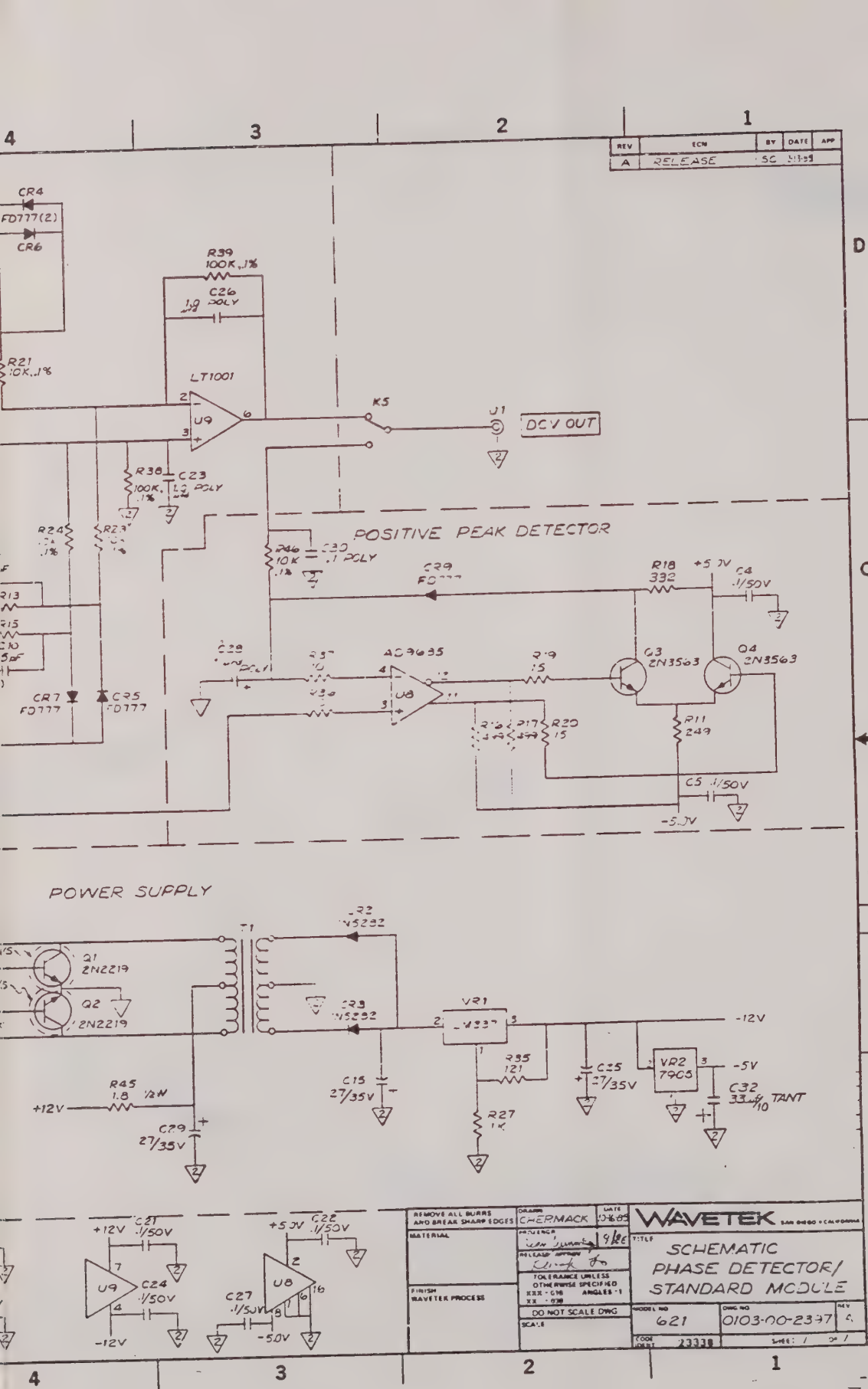


THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION, OPERATION, AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION.



3. ALL RELAYS ARE SHOWN IN NORMALLY OPEN POSITION.
2. ALL CAPACITORS ARE IN MICROFARADS.
1. ALL RESISTORS ARE 1/8W, METAL FILM CARBON, AND ARE IN OHMS.

NOTE UNLESS OTHERWISE SPECIFIED


REV
ECN
BY
DATE
APP
A
RELEASE
SC
CR4
FD777(2)
CR6
R39
100K,.1%
C26
.1µ POLY
R21
10K,.1%
LT1001
U9
K5
J1
DCV OUT
R38
100K,.1%
C23
.1µ POLY
POSITIVE PEAK DETECTOR
R24
R23
R36
10K
.1%
C30
.1 POLY
C29
FD777
R18
332
+5.1V
C4
.1/50V
R13
R15
C10
5pF
C28
.1µ POLY
R37
10
R38
AD9685
U8
R19
15
Q3
2N3563
Q4
2N3563
R16
R17
R20
15
R11
249
CR7
FD777
CR5
FD777
C5
.1/50V
-5.1V
POWER SUPPLY
T1
-R2
1N5232
Q1
2N2219
Q2
2N2219
CR9
1N5232
VR1
-V337
-12V
R35
121
C25
27/35V
VR2
7905
-5V
C32
33µF/10 TANT
R45
1.8 1/2W
+12V
C15
27/35V
C29
27/35V
R27
1K
C21
.1/50V
+12V
U9
C24
.1/50V
-12V
C22
.1/50V
+5V
U8
C27
.1/50V
-50V
REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH
WAVETEK PROCESS
DRAWN
CHERMACK
DATE
10-8-85
FREQUENCY
RELEASE APPROVAL
TOLERANCE UNLESS OTHERWISE SPECIFIED
XXX - .010 ANGLES - 1°
XX - .030
DO NOT SCALE DWG
SCALE
WAVETEK SAN DIEGO, CALIFORNIA
TITLE
SCHEMATIC
PHASE DETECTOR/
STANDARD MODULE
MODEL NO
621
DWG NO
0103-00-2397
REV
A
CODE IDENT
23338
SHEET 1 OF 1
4
3
2
1

Appendix A Basic Language Programming Example Listings

A.1 Peak Detector Program Listing

```
100 !*******************************************************
110 ! THIS PROGRAM MEASURES AMPLITUDE WITH THE
120 !      PEAK DETECTER ON THE MODEL 621
130 !*******************************************************
140 !     GPIB ADRESSES=704 FOR THE PRINTER
150 !                   711 FOR THE 604 SWITCHER CHASSIS
160 !                   709 FOR THE DVM
170 !*******************************************************
180 ! CONNECT THE 621 CARD TO THE VOLTAGE BEING MEASURED.
190 ! INSURE THAT THE MODEL 621 IS PLUGGED INTO SLOT XM1
200 !  OF THE MODEL 601 CHASSIS.
210 ! INSURE THAT THE AMPLITUDE IS = < 4V PEAK
220 !*******************************************************
230 ! THE NEXT LINE ROUTES CHANNEL ONE TO THE PEAK DETECTOR
240  WRITE @711:"XM1K1CK5CI"
250 ! THE NEXT LINE READS FROM THE DVM THE VALUE OF THE PEAK
260 ! DETECTOR OUTPUT.
270  READ @709:A$
280 !THE NEXT LINE DISPLAYS THE VALUE READ FROM THE DVM
290  PRINT A$
300 !THE NEXT THREE LINES PRODUCE A HARD COPY OF THE DVM VALUE
310  PRINTER IS @704
320  PRINT A$
330  PRINTER IS @0
340  END
```

```
  10  INPUT PROMPT "PHASE OFFSET?":P
 110  CLEAR
 120  INPUT PROMPT "NO. OF LOOPS?":H
 130  CLEAR
 140  INPUT PROMPT "AMPLITUDE?":G
 150  CLEAR
 160  INPUT PROMPT "MODULE NO. ?":A
 170  CLEAR
 180  INPUT PROMPT "START FREQUENCY:":FREQ
 190  LET FREQ=FREQ+FREQ
 200  IF FREQ>2000000 THEN LET FREQ=1999999
 205  LET L=0
 210  WRITE @709:"RESET"
 220  !
 230  !--------SET UP OF THE MODEL 650 $ SWITCHER--------
 240  !
 250  WRITE @711:"ZGXM".A."K2CK1OK5OI"
 260  WRITE @709:"CH 1 OT ONZ AM ".G.",FREQ ",FREQ." EXECUTE"
 270  WRITE @709:"CH 2 OT ONZ AM ".G." EXE"
 280 !CLEAR
 290  PRINT
 300  PRINT "PHASE ERROR AT ";FREQ;"HZ. ";G;"V P-P. MODULE XM":A
 310  PRINTER IS @704
 320  PRINT "PHASE ERROR AT ":FREQ;"HZ. ";G;"V P-P. MODULE XM":A
 330  PRINTER IS @0
 340  !
 350  !------------------MEASURE SCALE-----------------
 360  !
 370  LET PH=1
 380  GO SUB 710
 390  LET PHE91=PHERR
 400  LET PH=0
 410  GO SUB 710
 420  LET PHE90=PHERR
 430  LET SCALE=1/(PHE91-PHE90)
 440  PRINT
 450  PRINT "SCALE FACTOR = ":ROUND(SCALE.3)
 460  PRINTER IS @704
 470  PRINT "SCALE FACTOR = ":ROUND(SCALE.3)
 480  PRINTER IS @0
 490  PRINT
 500  WRITE @709:"FR ":FREQ;" EXECUTE"
 510  !
 520  !---------------SET/MEASURE ERROR----------------
 530  !
 540  PRINT "  FREQ          PHASE          TIME"
 550  PRINTER IS @704
 560  PRINT "  FREQ          PHASE          TIME"
 570  PRINTER IS @0
 580  LET PH=P
```

```
590   GO SUB 710
600   LET ERROR=ROUND(PHERR*SCALE,4)
610   PRINT USING 650:FREQ,ERROR,TIME$
620   PRINTER IS @704
630   PRINT USING 650:FREQ,ERROR,TIME$
640   PRINTER IS @0
650   IMAGE:  #######       ##.###          ##########
660   LET L=L+1
670   IF L<H THEN GO TO 580 ELSE GO TO 190
680 !
690 !--------------------PHASE MEASUREMENT-------------
700 !
710   WRITE @709:"CH 2 PH ",90+PH," EXE"
720   WRITE @711:"XM",A,"K6OI"
730   LET Z=READDVM(0)      CALL READDVM(0,Z)
740   WRITE @711:"XM",A,"K6CI"
750   LET W=READDVM(0)      CALL READDVM(0,W)
760   WRITE @709:"CH 2 PH ",-90+PH," EXE"
770   WRITE @711:"XM",A,"K6OI"
780   LET C=READDVM(0)
790   WRITE @711:"XM",A,"K6CI"
800   LET D=READDVM(0)
810 !
820 !---------------PHASE ERROR CALCULATION----------
830 !
840   LET PHERR=(Z+W-C-D)/4
850   RETURN
860 !
870 !-----------------DVM RESOLUTION-------------------
880 !
890   DEF READDVM(X)        SUB READDVM(X,# RETURN_VALUE)
900     IF X=1 THEN WRITE @708:"F2N5" ELSE WRITE @708:"F1N5"
910     LET V1=0
920     LET V2=0
930     WRITE @708:"T3"
940     READ @708:V2
950     IF FREQ>10000 THEN LET WINDOW=.002 ELSE LET WINDOW=.0005
960     IF ABS(V2-V1)<WINDOW THEN 1000
970     LET V1=V2
980     WAIT DELAY .5
990     GO TO 930
1000    DEFEXIT READDVM=V2          RETURN_VALUE = V2
1010  END DEF
1020  END
```

MP MASTER
MA35665